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PLANT BREEDING IN RELATION TO FOOD PRODUCTION

INDIA has never been a surplus country with regard to her food grains. The population has been increasing by nearly ten per cent. every ten years but the production has not kept pace with this increase in population. The normal small exports of the country are more than counterbalanced by imports from outside. It has to be remembered in this connection that the statistics of production figures available in the country, are hardly reliable and ways and means of obtaining more accurate figures for production, are still under investigation.

The chief food grains of the country are, in the order of their importance, rice, wheat and millets (including jowar). Of the above, wheat is a cold weather crop grown under irrigation in Northern India,—Sind, Punjab, U.P. and Bihar—and as a rain-fed crop chiefly in the black cotton soils of peninsular India. A large part of the area under millets is also confined to the black cotton soils of peninsular India and in several cases, the success of the crop depends upon a good and well distributed monsoon. In contrast with the above two, rice production is associated with a more plentiful supply of water either in the shape of monsoon rains or special irrigation systems. The rice area is mainly confined to East India,—Assam, Bengal, Bihar, Orissa, C.P., Madras and the narrow belt of land on the west lying between the Arabian Sea and the Western Ghats. Since rice forms the staple food of a large majority of the Indian population, it is the production of this crop that determines the deficit or surplus position of the country with regard to its food requirements. Even in years when the deficit was considerable it did not cause any anxiety so long as there was Burma nearby with a large exportable surplus of the commodity. Time there was, not at a very distant date, when with the prospect of getting rice cheaply from Burma where the cost of production is comparatively cheaper than in India, the question of actually reducing the area under rice in favour of industrial crops was even thought of. In fact, the question was seriously considered at a Crop Planning Conference held under the auspices of the Imperial Council of Agricultural Research nearly ten years back. The idea was, however, dropped due to the opposition from certain provinces where, under the system of rice cultivation practised in concentrated areas, there was not much scope to introduce alternative crops. The present war and the loss of Burma has brought home the danger of depending upon foreign imports for the most important food grain of the country. For a large country like India with an enormous and ever-increasing population and where, over a large part, the success of crop production depends upon the vicissitudes of the monsoon, it is necessary that the country should be made as self-sufficient as possible for its food requirements. It is very unlikely that after the cessation of the war the question of overproduction of food crops will cause difficulties, and even if it should, the proper course would be to absorb the surplus in industrial concerns.

The immediate and pressing problem is to increase the production of food crops. To attempt this, two ways are open to us:

(i) Increasing the acre yields in the existing areas by (*a*) substituting ordinary varieties grown by the cultivators by the improved ones evolved by the plant breeders and (*b*) by adopting intensive manuring practices.

(ii) Increasing the area under food crops by (*a*) either designing new irrigation systems or making adjustments in the existing irrigation projects and (*b*) substituting areas under non-food crops with food crops.

Improved Varieties as a Means of Increasing Acre Yields

It is well recognised that successful plant breeding work by itself can improve the production by at least ten per cent. If the existing varieties are systematically replaced by improved ones by well-planned seed multiplication and distribution schemes. Growing an improved variety costs the cultivator no additional expenditure and no difficulty has been experienced anywhere about the cultivator being unwilling to take up the improved variety. It is sometimes pointed out that in spite of the fact that plant breeders have been working for several years and producing new varieties, the area in the country under such improved varieties, forms only a small fraction of the total area under the respective crops. This may partly be due to want of experimental data obtained by extensive trials in cultivators' fields to decide upon the superiority of the improved kinds for particular areas. But even where such data are available, that the area under improved varieties has not increased, is mainly due to the aversion of Provincial Governments to finance seed distribution schemes. Punjab is, however, an exception where large amounts are spent annually on seed distribution schemes, and when once the superiority of an improved variety is established, seed schemes are immediately put into operation. It may be pointed out that seed schemes are by no means a net expenditure to the Provincial Government and that well-planned schemes can actually be made self-supporting. The exigencies of war and the shortage of food, have now made the Provincial Governments realise the importance of supplying pure seed to the cultivators as a sure and easy means of augmenting production and several governments have now provided liberal grants for seed schemes. This work should be extended by every possible means wherever improved varieties found suitable to particular tracts, are already available. It might happen that some of the varieties with the breeder may require further testing out in cultivators' fields and this could be undertaken immediately. Due to differences in the intensity of breeding work carried out in the various provinces, some might be more favourably situated than others with regard to the availability of improved varieties for different tracts. For example, in Madras it should be possible to recommend improved varieties for all the major rice tracts of the province.

Intensive Manuring as a Means of Increasing Acre Yields

Apart from water being a general limiting factor for crop outturn, it has an indirect relationship to manuring practices. In crops like rain-fed wheats and millets there is probably not much scope of increasing acre yields by manuring as an emergency measure. The fertility here has to be gradually built up by a continuous application of cattle manure or composts. Irrigated wheats, however, come under a different category and increasing their acre yields by manuring should be possible. There are indications of oil cakes in C.P. and ammonium sulphate in Punjab giving profitable increases in yield. But we have no extensive experimental data to go by to make immediate recommendations. The available information about rice manuring is happily much more definite. Ammonium sulphate, oil cakes and green manuring are all known to give profitable increase in yields in several areas.

Due to war conditions ammonium sulphate is not available in quantities nor at remunerative rates. It has been suggested recently that the resolution of the United Nations Food Conference "that Governments which need fertilisers should be supplied with them subject to the exigencies of war", might be given effect to. If it is possible to import the necessary machinery to manufacture sufficient ammonium sulphate in the country, it should help in increasing rice production immediately. That acre yields of rice in other countries are much higher than in India is due to the fact that the soils there are not only more inherently fertile than in India but also receive fertilisers to the extent of 70-100 lbs. of N. per acre whereas in India, the majority of the rice lands do not get any manure at all. It has been shown that in parts of Madras, acre yields comparable to the foreign countries could be obtained with intensive manuring. With regard to oil cakes the areas where rice is cultivated extensively are not those where oil seed crops come in the cropping and making oil cakes available to the cultivators at remunerative rates appears to be a question of overcoming transport difficulties. Lastly, wherever rice is grown in India, any form of green manuring has always proved profitable. Besides green manuring other bulky manures like composts, municipal wastes, etc., are also useful for rice and the use of these should be encouraged by every possible means.

It has to be mentioned, however, that it will not be enough if the use of either improved seed or manures is simply recommended; they should actually be made available at every rural centre at reasonable prices. It may be mentioned here that the general experience has been that the improved varieties respond better to intensive manuring than unselected kinds. There is no doubt that the growing of improved varieties coupled with intensive

methods of cultivation, particularly manuring, wherever possible, should soon make the country self-sufficient with regard to the country's requirements of rice.

Increasing the Crop Area by either Designing of New Irrigation Projects or Adjusting the Present Ones

Starting of fresh irrigation projects to bring new areas under food crops though it involves capital expenditure is a sure way of increasing food production. The recent appointment of a special irrigation adviser with the Government of India, is a move in the right direction. It would probably be worth while to put an irrigation engineer on special duty in each of the provinces where irrigated rice is an important crop. The possibilities of starting new minor projects or improving such of the old ones that have gone out of use would receive adequate attention in that case. The examination of improving irrigation facilities should particularly be welcome in provinces like Bengal and Bihar where, in spite of their large areas, the acre yields are comparatively low mainly for the reason that in a greater portion of their rice areas there is scarcity of water at critical periods of plant growth though there may be a surfeit of it at other times. Minor adjustments in the existing irrigation systems might help in increasing the area under the crop. For instance, where a single crop of about five months duration is at present grown, it should be possible to grow two short-duration crops in quick succession in the same season. Similarly in tracts where both single crop and double crop areas exist, and where the latter form only a small fraction of the total area, the percentage of the double crop area could be increased by adjusting the time of opening and closing of the irrigation channels. This last suggestion is already being given effect to in parts of Madras.

While considering irrigation projects the question of the large inundated areas on the seacoast in Bengal, Orissa, parts of Madras and Bombay where rice is at present a very precarious crop may also be thought of. While breeders may be expected to recommend as a result of research, varieties that could withstand flooding or a slight salinity in the water, making the area safe for rice cultivation is essentially an engineering problem. It might mean considerable capital expenditure but still it is a problem worth investigating from the view-point of the ultimate increase in the food production of the country.

The success of either new projects or improvements in the existing ones will depend to a large extent on the right choice of the varieties to be grown. The breeder with local experience should be able to give the necessary advice, and in any case, it is necessary that the irrigation authorities should work in close collaboration with the breeder.

In the attempt to bring more area under food crops the large areas shown as uncultivated wastes in the revenue statistics of *ryotwari* provinces could be thought of. In several causes such areas may not actually be cultivable for various reasons such as, rocky or poor nature of the soil, absence of water facilities, absence of people in the locality being unhealthy spots, etc. The immediate necessity is to make a proper survey of these areas with a view to determine what portions of such areas could be brought under crops and what facilities they would need. There are also the broad strips of waste land lying on either side of railway lines. A good portion of them is capable of growing food crops and the question is to determine whereall it could be done without endangering the safety of the permanent ways.

Substituting Non-Food Crops by Food Crops

The scope for this appears to lie mainly in the rain-fed tracts. The only crop that can be replaced by food crops is the short staple cotton and while considerable progress has already been made in this direction in parts of C.P. and Hyderabad, its success would appear to depend upon the cultivator being compensated in cash for the change-over as the growing of short staple cotton still brings him a greater raturn than the food crops. In irrigated lands where the non-food crops that are chiefly grown are cotton and sugarcane, the disparity in the returns between food and non-food crops even at the present rate of food grains is greater than in the rain-fed tracts, and to induce cultivators to go in for food crops might prove impracticable unless they are going to be sufficiently compensated.

Post-War Problem of Food Production

So far we have discussed the question of increasing food production as an emergency measure. Equally, if not more important, is the question of making the country self-sufficient with regard to food requirements even in the post-war period so that we shall never again find ourselves placed in a difficult situation like the present one. It has been already stated that successful plant breeding and production of improved varieties is a sure and the least expensive method of improving the acre outturns. Any expenditure on plant breeding work should give returns several fold. It is, in fact, the results of plant breeding work that form the chief plank on which most of the activities of the provincial agricultural departments depend. We shall now examine the scope and position of plant breeding work in the country with regard to the three chief food crops.

Wheat was the first crop to receive attention at the hands of Sir Albert Howard and his improved varieties had spread all over India, particularly Northern India, and outside India as well. The breeding work in this crop is now being carried on by the Imperial Economic Botanist at the Imperial Agricultural Research Institute, New Delhi. Some of the wheats bred at Delhi are expected to be found suitable for parts of U.P. and Bihar. Punjab has its own wheat botanist and certain new varieties bred by him have completely replaced Howard's wheats in the province. The wheats grown in Sind are either those of Pusa or of the Punjab. So far as peninsular India is concerned where a different wheat (*durum*) is grown, the

problem is separate and has to be dealt with independently. Work on this wheat is going on in Bombay, C.P., Hyderabad (Dn.) and Indore. Apart from the two main divisions, the irrigated bread wheats of N. India and rain-fed *durum* wheats of peninsular India, there is a fair amount of adaptability within the two groups. Wheats bred at one centre may do equally well at another. This should not be taken to mean, however, that the breeding work could be sufficiently centralised. It is quite likely that if independent and intensive breeding schemes are carried out in U.P. or Bihar, there should become available varieties even better than either Howard's wheats or the new wheats bred at Delhi. There are always bound to be local differences and adaptations of the crop to such differences.

With regard to millets which are of comparatively greater importance to peninsular India, work has been going on in Madras, Bombay, C.P., Hyderabad, Mysore, Indore, etc., but from the results available it would appear there is considerable scope for further intensification of the work. Breeding in millets is comparatively a more difficult task as the failure or an uneven distribution of the monsoon might easily upset the whole programme of work. The importance of the work on some of the minor millets has been recognised recently and breeding schemes have now been started in several provinces and States with finance partly provided by the Imperial Council of Agricultural Research.

Coming to rice, each of the rice provinces has now got either a whole-time or part-time plant breeder and the Imperial Council of Agricultural Research has been responsible for intensifying this work in some of the provinces with liberally provided finance during the last ten years. There are several improved varieties evolved by the breeders in the chief rice provinces already available with which seed schemes are in progress. One thing that has to be emphasised in the case of rice is that it has a limited adaptability, and it is within the experience of breeders that improved varieties from another province or even from a different tract within the same province have often proved failures. Work for each tract has to be done independently and the ideal arrangement should be to have as many breeding stations as the number of individual tracts with varying conditions warrant. Madras might probably be mentioned as an example of having adopted this policy. The paucity of sufficient number of stations should make it apparent how much yet remains to be done, for example, in a predominantly rice province like Bengal.

Scope of Plant Breeding Science

There is no doubt that to carry out breeding work more thoroughly and more intensively for a country of the size of India, we shall require several more trained plant breeders and breeding stations than what we have at present. The magnitude of the work needs no emphasis. Varieties superior to what is commonly grown by the cultivators have to be evolved for millions of acres on which unselected mixed types still continue to be grown. Plant breeding involves not only production of varieties with greater yields but also varieties that could resist pests, diseases, drought, salinity in the soil or water, etc. The time is past when plant breeding was considered more an art than a science. Plant breeding science touches in its sphere of activities several branches of botanical science, like taxonomy, genetics, cytology, pathology, physiology, etc. Great advances have taken place in recent days in these branches of science and proficiency in any or all of these cannot alone make a successful plant breeder. A breeder to be successful should not only know something of these sciences but also keep abreast of the latest developments and utilise them as tools in his own sphere of work. His work consists mainly in the field, making continuous observations on the growing plant and sifting the variable material. Besides the above sciences, statistics has come to play an ever-increasing part in giving a precision and objectiveness in the technique of breeding. It has partly dispensed with the trial and error methods of earlier plant breeders and no plant breeder worth the name can afford to neglect statistics.

While it is true that the practical achievements of plant breeding research in India would compare very favourably with any of the more advanced countries of the world, it has yet to be admitted that the number of successful breeders available in the country is hardly commensurate with the immensity of the problem. In India where the work is still in its infancy it is quite an easy matter to produce an improvement from the widely variable natural material available, but it cannot be said that the technique adopted in the difficult centres is not capable of being improved upon. Faulty technique is bound to cause delay in obtaining of successful results and this, a comparatively poor country like India, cannot afford.

Training of Plant Breeders

What are the facilities available in the country of the size of India to turn out plant breeders of the required calibre? The only countries with which India can be compared in this respect are Russia and U.S.A. and such a comparison immediately brings out the very poor position of India both with regard to training centres and the personnel capable of giving the necessary training. The tremendous advance Russia had made just before the present war started with regard to increasing the production of its raw products including food grains was achieved, not by tinkering with the problem, but by creating an army of trained men and distributing them for work throughout the length and breadth of the country. In India, besides the Imperial Department of Agricultural Research at New Delhi, the provincial departments of agriculture have their own Crop Specialists or Economic Botanists to deal with the problem of improvement of crops. The staff under these experts consist of men who possess a University degree either in Botany or Agriculture and they start learning work only after they join the department; the

training thus obtained might not be all that is desired. No provincial agricultural college has got a definite post-graduate training scheme.

In U.S.A., besides the workers in individual States either on Government employment or attached to the Universities, there is the federal Government which has also a large agricultural department with a team of research workers and there are schemes directly under their control not only at federal headquarters but also scattered in the different States to supplement the work which the individual States might already be doing. The Imperial Council of Agricultural Research in India no doubt functions to a certain extent on the model of the federal department of agriculture in U.S.A. but it has not got the expert technical personnel to help or give guidance to workers in individual provinces or States. This is a matter that requires consideration from the point of view of all-India interest. Apart from other considerations, it will be well if the Imperial Council of Agricultural Research could examine at least the question of providing for the country competent personnel in sufficient numbers with sound training in plant breeding. It is quite likely that at least some of the agricultural research centres already existing in the country could be utilised as training centres with additional facilities provided wherever found necessary.

In conclusion, it may be definitely stated that plant breeding research offers the greatest scope for increasing the food production of the country not only as an emergency measure under the present conditions but also as a long-range measure in the post-war period.

PROF. H. J. BHABHA, F.R.S.

PROF. H. J. BHABHA, F.R.S., has been awarded the Adams Prize for 1941-42 by the University of Cambridge. Readers of *Current Science* will rejoice to learn that Prof. Bhabha is the first Indian to win this unique distinction.

The Adams Prize, valued at about £300, is awarded every even year for the best essay on some subject pertaining to pure mathematics, astronomy or some other branch of natural philosophy. Any person, who has at any time been admitted to a degree in the University of Cambridge, can compete for this coveted Prize, which is looked upon as one of the highest distinctions for distinguished scholarship and exceptional ability at exposition by all research workers. Quite often the award of the Prize could not be made for want of recipients as the standard set is extremely high. Between 1850 and 1913 this Prize was awarded only fifteen times! The list of Adams Prize winners includes the names of some of the greatest scientists of England, *viz.*, Maxwell, J. J. Thomson, Poynting, Larmor, Love, McLarin, Jeans and Fowler.

The subject of the essay for which Professor Bhabha was awarded the Prize was "The theory of elementary physical particles and their interactions". Prof. Bhabha is among the world's foremost workers in this field and has made many original contributions of fundamental importance to this subject during the last few years. Prof. Bhabha's presidential address to the Physics Section of the Indian Science Congress at its last session, was on the same subject and, in that address, he has indicated some of his ideas on the latest developments of the subject very clearly. This address was the subject of an excellent article by Sir Ralph Fowler, F.R.S., in the *Nature* of 5th June 1943.

Prof. Bhabha, at the moment, is engaged in writing a book on this subject, to be published by the Oxford University Press, and the Adams Prize essay forms only a part of the volume. We have no doubt this book will be most welcome as it will be the first systematic and logical development of the modern theory of the elementary particles of nature.

We offer our heartiest congratulations to Prof. Bhabha on this occasion. He is still in his early thirties and we wish him many long years of eventful research and greater distinctions to crown his scientific endeavours.

CO-ORDINATION OF RESEARCH IN UNIVERSITIES

DELIVERING the inaugural address of the Madras University Research Scholars' Association, Sir C. P. Ramaswami Ayyar, Dewan of Travancore, appealed to universities in South India to pool their resources and co-ordinate research work. The universities could sit together, confer together on their work so that there might be an interchange of students and professors and to avoid duplication and competition in the future. He would be a false prophet who forecast that, at the close of the war, there was going to be the best possible world ushered in. The post-war world would be a ruthless competitive world.

There was everywhere a great deal of talk about international gatherings and a considerable amount of research devoted to the new order of things. Whatever might result from such efforts there was no gainsaying that India would have to establish her industries and commerce not in a world of peace but in a world in which other countries, which were better able to produce and sell, would compete with her.

Unless India was abreast of the industrial nations of the world, she would be swept off by the current. It was from this point of view that they, in Travancore, had planned research schemes in their university.

STUDIES ON THE PRESERVATION OF GLANDS

I. The Preservation of Adrenal Glands

By B. B. DEY, P. S. KRISHNAN and V. SRINIVASAN
(Presidency College, Madras)

A CENTRAL factory in our country for the large-scale production of gland products can be thought of only when we solve the problem of storage and transport of the glands. It is a well-known fact that the gland tissue suffers autolysis with simultaneous destruction of hormonal activity unless proper precautions are taken to preserve these glands. Three methods suggest themselves for the proper preservation of glands: (1) The use of low temperatures, which will arrest enzyme activity—an entirely physical method, (2) use of chemical preservatives which inhibit bacterial action and (3) a combination of both.

The present investigation concerns itself with the changes in the adrenaline and vitamin C contents of the adrenal glands stored under various conditions. The methods employed for the estimation of adrenaline and vitamin C have already been described elsewhere (Dey, Krishnan and Srinivasan[1]). In all cases, unless otherwise stated, the glands after collection from the slaughtered animals, were transported to the laboratory packed in melting ice. The glands were kept for varying periods at different temperatures: (i) room temperature (30°-32° C.), (ii) Frigidaire temperature (3°-5° C.), (iii) in the frozen condition, the freezing being effected either by placing in the freezing chamber of the Frigidaire (a temp. of — 7° C.) or by packing in solid carbon dioxide (— 30° C.). In the first two cases a few drops of toluene were added as preservative. In a separate series of experiments (No. V in Tables I and II), the estimations were carried out on glands without the addition of toluene. Investigations were also carried out on the changes in the adrenaline content of glands which were stored in alcohol at room temperature for a period of one week. The values given in the following tables represent the mean of a series of estimations.

It has already been indicated (*loc. cit.*) that greater reliance has to be placed on the persulphate colorimetric method and the indophenol titration method for the accurate estimation of adrenaline and ascorbic acid respectively. As is obvious from Tables I and II,

TABLE I
Cattle glands (whole)

Method of storage	Period of storage	Adrenaline: Weight (mg.) per gram of gland		Vitamin C: Weight (mg.) per gram of gland	
		Folin	Persulphate	Indicator	Iodine
(i) Fresh glands transported to the laboratory in melting ice	2–3 hours after death of animal	3·05	1·85	0·91	1·09
(ii) Freezing with "dry ice" ..	2 days	3·05	1·73	0·89	1·15
(iii) Freezing in the Frigidaire ..	24 hours	2·74	1·72	0·80	1·09
	3 days	2·56	1·73	0·79	1·11
	7 days	2·63	1·58	0·65	0·99
	14 days	2·36	1·52	0·66	0·94
	1 month	2·55	1·59	0·77	1·11
(iv) Keeping at Frigidaire temperature with a few drops of toluene	24 hours	2·69	1·73	0·93	1·26
	2 days	2·68	1·68	0·69	0·98
	3 days	2·66	1·64	0·72	0·96
	4 days Putrefaction sets in	2·70	1·30	0·21	0·37
(v) Keeping at Frigidaire temperature without toluene	24 hours	3·13	1·75	0·98	1·32
	2 days Putrefaction sets in	2·44	1·59	0·85	1·18
(vi) Keeping at room temperature with a few drops of toluene	16 hours Putrefaction sets in	3·16	1·66	0·70	0·94
(vii) Preservation in alcohol	8 days	2·03	1·65	0·08	0·12

TABLE II

Sheep glands (whole)

Method of storage	Period of storage	Adrenaline		Vitamin C	
		Weight (mg.) per gram of gland		Weight (mg.) per gram of gland	
		Folin	Persulphate	Indicator	Iodine
(i) Fresh glands transported to the laboratory in melting ice	2–3 hours after death of animal	2·54	1·57	1·30	1·73
(ii) Freezing with " dry ice " ..	2 days	1·81	1·07	1·09	1·49
(iii) Freezing in the Frigidaire ..	24 hours	1·79	1·06	0·97	1·48
	3 days	1·92	1·06	0·98	1·40
	7 days	1·88	0·90	0·96	1·41
	14 days	1·87	0·88	0·92	1·32
	1 month	2·02	0·69	0·94	1·26
(iv) Keeping at Frigidaire temperature with a few drops of toluene	24 hours	2·40	1·18	1·03	1·45
	2 days	2·01	1·01	0·82	1·10
	3 days Putrefaction sets in	1·96	0·78	0·62	1·03
(v) Keeping at Frigidaire temperature without toluene	24 hours	1·82	1·03	1·19	1·60
	2 days Putrefaction sets in	1·64	0·65	0·95	1·28
(vi) Keeping at room temperature with a few drops of toluene	16 hours Putrefaction sets in	1·61	0·90	0·82	1·17
(vii) Preservation in alcohol	7 days	1·37	1·44	0·016	0·027

sheep glands, as a rule, suffer greater decomposition in adrenaline and vitamin C than cattle glands, stored under identical conditions, due probably to the softer texture of the former. Glands in the frozen condition can be stored without undergoing deterioration for several weeks. At the end of one month, the loss of adrenaline (as estimated by the specific persulphate oxidation reaction) is only about 15 per cent. in the case of cattle glands. In the case of sheep glands, however, the decomposition of adrenaline under these conditions is extensive (more than 50 per cent.). The analyses of adrenal glands, both cattle and sheep, frozen for 2 to 3 days either with CO_2 snow or by placing in the freezing chamber, show that the loss of adrenaline is not very appreciable. At the frigidaire temperature of 3 to 5° C., with toluene as preservative, the glands keep well for 2 to 3 days, the loss in adrenaline being only about 15 per cent., after which time putrefaction sets in. If no toluene is added the glands putrefy some 24 hours earlier. Kept at laboratory temperature, with a few drops of toluene, the glands develop smell in 12 to 18 hours' time, although adrenaline, as estimated by the persulphate method, does not suffer any serious loss. In all the above cases vitamin C also showed progressive decomposition although no definite correlation is apparent between the relative destruction of the adrenaline and the vitamin. Preservation of glands in alcohol is very effective; at the end of one week the loss of adrenaline in the case of cattle glands is 11 per cent. and in the case of sheep glands 8 per cent. Vitamin C, however, suffers extensive destruction under these conditions.

Much stress is often laid on the post-mortem diffusion of adrenaline from the medulla into the cortex. The glands which were frozen for one month, were then dissected carefully, and the medulla and cortex assayed separately for the adrenaline and vitamin C contents. The figures in Tables III and IV show that the medulla contains 63 and 71 per cent. of the total adrenaline in the case of the cattle and sheep glands respectively, as compared with 82 per cent. in the case of the fresh glands, showing thereby that a certain amount of diffusion has taken place.

In still another series of investigations (Table V) the glands, soon after collection from the slaughtered animals, were chilled by dropping into 'dry ice' and transported in this condition from the slaughter house to the laboratory, where they were immediately worked up. The values so obtained (*vide* Table V) show

TABLE III

Cattle glands (dissected)

Method of preservation	Adrenaline				Vitamin C			
	Weight (mg.) per gram of tissue				Weight (mg.) per gram of tissue			
	Medulla		Cortex		Medulla		Cortex	
	Folin	Persulphate	Folin	Persulphate	Indicator	Iodine	Indicator	Iodine
(i) Fresh glands ..	6·57	4·8	1·27	0·37	0·93	1·33	1·06	1·38
(ii) After freezing in the Frigidaire for one month	5·72	3·80	1·86	0·86	0·83	1·17	0·43	0·80

TABLE IV

Sheep glands (dissected)

Method of preservation	Adrenaline				Vitamin C			
	Weight (mg.) per gram of tissue				Weight (mg.) per gram of tissue			
	Medulla		Cortex		Medulla		Cortex	
	Folin	Persulphate	Folin	Persulphate	Indicator	Iodine	Indicator	Iodine
(i) Fresh glands ..	6·50	5·52	1·17	0·31	0·99	1·46	1·45	1·87
(ii) After freezing in the Frigidaire for one month	2·80	2·21	1·45	0·20	0·54	0·88	0·45	0·68

TABLE V

Instantaneous chilling of the glands with solid carbon dioxide

Animal	Adrenaline		Vitamin C	
	Weight (mg.) per gram of gland		Weight (mg.) per gram of gland	
	Folin	Persulphate	Indicator	Iodine
(i) Cattle	3·71	2·24	1·24	1·65
(ii) Sheep	2·52	1·60	1·36	1·71

a definite increase for both adrenaline and vitamin C, over those obtained for glands transported to the laboratory in melting ice.

A detailed discussion and interpretation of the results obtained will be published elsewhere. It is apparent, however, that for obtaining the maximum yield of adrenaline, the ideal procedure would be to chill the glands soon after collection from the slaughtered animals and to work them up within twenty-four hours. If the glands could be kept frozen, they could be transported even to distant places without seriously impairing their adrenaline contents. A cheaper, though less satisfactory method, which is practicable under the present-day conditions, would be to pack the glands (which have been sprinkled over with toluene) in ice and work them up in 2-3 days' time. Storage in alcohol also seems to hold out good prospects.

The expenses of this investigation have been met entirely from funds supplied by the Board of Scientific and Industrial Research, to whom our grateful thanks are due.

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THE AMPHIBIAN SPERM

By B. R. SESHACHAR, D.Sc., F.Z.S.

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THE Amphibia with its three existing orders, Urodela, Anura and Apoda, offers three different types of sperm structure. The Urodelan and Anuran sperms have been the subject of a number of memoirs which have dealt with their structure and development while the Apodan sperm has not been studied till now. Recently the author (1943*a*) has been able to work out in detail the sperm development in an Apodan example, *Ichthyophis glutinosus* and so it is possible for the first time to offer a comparative account of the sperms of the three groups of Amphibia.

The work of Meves (1897), MacGregor (1899), Broman (1900, 1901), Retzius (1906), King (1907), Terni (1911), Ballowitz (1913), Champy (1913, 1923), Morita (1928) and Gatenby (1931) has thrown considerable light on Urodelan and Anuran spermateleosis. This work has established one fact of importance, i.e., that the sperms of these two groups are thoroughly unlike each other, and while anatomically these two great Amphibian orders are closely related, their spermatozoa fall under two entirely different categories.

The Anuran sperm is of uniform structure with a small acrosome surmounting an elongated nucleus behind which the two centrioles are lodged close together, and from the distal centriole the tail filament issues either as a simple flagellum (*Rana, Hyla, Pelobates*) or as one with an undulating membrane (*Alytes, Bufo, Bombina, Discoglossus*). The base of the flagellum is ensheathed by mitochondria which may or may not form a spiral investment and this mitochondrial sheath is often referred to as the 'middle piece' of the sperm (Fig. 1 *B*). In the case of *Hyla* (Retzius, 1906) there is a slight space separating the two centrioles and this space with its mitochondrial aggregation is called the 'middle piece'. The spermatozoon of *Bombinator* (Broman, 1900) is very peculiar in that the centrioles are situated, not behind the nucleus, but to a side of it anteriorly so that the flagellum runs parallel to the elongate nucleus during much of its course.

Compared with this simple sperm of Anura, that of the Urodela has a very complex structure. The acrosome and nucleus occupy the anterior end of the spermatozoon and are liable to considerable variation in size and shape. Closely following the nucleus is a conspicuous solid body of large size (Fig. 1 *A*). This is the proximal centriole which has become greatly enlarged and forms one of the constant features of the urodele sperm. Behind this trails the axial filament. The distal centriole undergoes a curious modification. It becomes converted into a ring which elongates greatly and lies on the side of the axial filament for most of its length. The mitochondria are generally absent from the adult urodele sperm.

As already observed, the Apodan sperm has not been studied at all and the only observation regarding it is that by the Sarasins (1890) who have provided a very meagre account of the sperm of *Ichthyophis glutinosus*. Its structure and development have been studied by me (1943*a*) recently and as a result, it is possible for the first time to compare it with the sperms of Urodela and Anura. In the Apodan sperm (Fig. 1 *C*) the acrosome and nucleus are followed by a short 'middle piece' which is a spiral aggregation of mitochondria around the base of the flagellum. The two centrioles are in close and intimate relation with the nucleus, the proximal fused with it posteriorly as a flat disc with a single perforation. The distal centriole becomes an elongated granule, which, passing through the orifice of the disc-shaped proximal centriole, becomes embedded in the nucleus. The

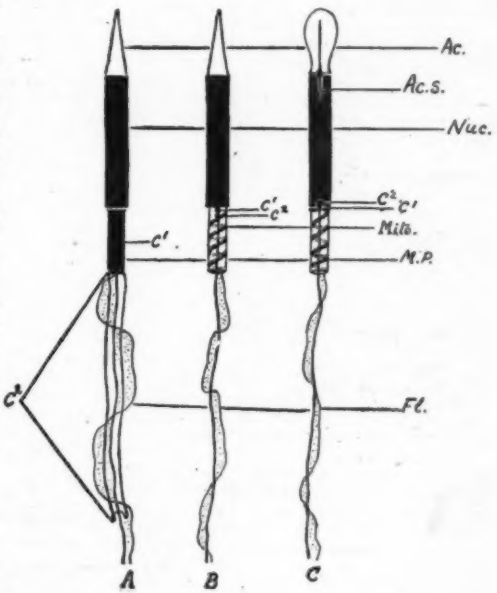

FIG 1. Diagram showing the structure of the sperms of Amphibia. *A*. Urodele sperm; *B*. Anuran sperm; *C*. Apodan sperm.

Ac. Acrosome; *Ac. s.* Acrosome seat; C^1. Proximal centriole; C^2. Distal centriole; *Fl.* Flagellum; *Mito.* Mitochondria; *M.P.* Middle piece; *Nuc.* Nucleus.

flagellum of the axial filament is provided with an undulating membrane which extends over a great part of its length.

The Acrosome and Its Seat.—The acrosome in Amphibia varies greatly in size, form and appearance. In most Anura (*Rana, Hyla, Bufo, Alytes*) it is a pointed lance-shaped body surmounting the nucleus. In *Pelobates* (Broman, 1901) it is of great length and twisted in a more or less cork-screw fashion. In *Discoglossus* (Champy, 1923) also it is extremely long and filiform and makes up half the length of the sperm. In urodeles, it is more variable. The acrosome of *Pleurodeles* and *Triton* resembles that of the Anura in being a lance-shaped pointed structure but in *Molge* it is bent in the form of a fish-hook (Ballowitz, 1913). All variations between these two forms may occur. The acrosome of the Apodan sperm is a bulb-shaped structure with a narrow stalk planted on the nucleus. In the five species of Apoda examined by me (*Ichthyophis glutinosus, Uræotyphlus narayani, Dermophis gregorii, Siphonops annulatus* and *Gegenophis carnosus*) the acrosome has this shape. The pointed acrosome in many animals has led to the belief that it helps in the penetration of the egg membranes during fertilisation and hence has been called the perforatorium. More recently with the discovery in a number of animal sperms of an acrosome which is of such a shape that an act of perforation is difficult if not impossible, this view has been given up in favour of the one whereby, the egg itself, by means of the changes taking place in its outer constitution, becomes capable of engulfing the sperm, so that penetration of the sperm into the egg is an act largely of the egg rather than of the sperm (Wilson, 1928). The Apodan sperm is a case in point, as here the sperm with its blunt and rounded acrosome could not perforate the egg membranes.

The acrosome and the nucleus being quite separate bodies, the union between the two is by means of a mechanism whose real nature has been obscure for a long time. Gatenby (1931) was probably the first worker to draw attention to this fact and in his work on the development of the spermatozoon in Urodela has correlated the presence of certain deeply staining granules with the formation of an acrosome seat in relation with the nucleus into which the acrosome is fitted. Earlier, similar granules had been noticed by Meves (1897), MacGregor (1899), Terni (1911) and Bowen (1922) in other Urodela, without however, their real significance having been understood. Recently I have described the acrosome seat in the Apodan form *Ichthyophis*. The acrosome gives off a lance-shaped plug which fits into a pit in the centre of the nucleus so that the two are held together firmly (Fig. 1 *C*, *Ac. s.*). No other account of the acrosome seat exists in regard to the Amphibian sperm but it is more than likely that future work will show that in all animals the acrosome and the nucleus are incorporated with each other by means of an apparatus which, while varying in the details of its constitution, is uniform in that its main function is to cement the acrosome and the nucleus.

The Nucleus.—The nucleus which, with the acrosome, constitutes the head of the spermatozoon, is also variable in form in the Amphibia but generally within not very wide limits. In the Urodela and Anura its form and shape are generally uniform. It is a deeply staining body, either cylindrical or pointed towards the anterior end (*Rana, Bufo, Triton, Alytes*). In *Bombinator* it is elongated, and broad anteriorly and pointed posteriorly. In the Apoda too there is a great uniformity in the matter of shape and form of the sperm nucleus. In the five species the author has been able to examine (1943) it is an elongated cylinder. In the matter of the size of the nucleus, however, there is no uniformity. I have recently attempted a line of study with a view to determine the volume relationships of the sperm nucleus and the nucleus of the spermatid. It is a matter of common knowledge that one of the most important changes involving the nucleus in spermateleosis is its condensation and consolidation and it is believed that in its transformation from the spermatid to the spermatozoon, the nucleus undergoes a progressive reduction in volume, presumably due to loss of fluid from the nucleus. The nucleus of the adult sperm, therefore, is a packed mass of chromatin in which no details of structure can be made out. The question naturally arises as to what the relationship is between the volume of the nucleus of the spermatid and that of the adult spermatozoon. No work on these lines has been done in any group of animals and it has been shown for the first time that so far as the Apoda are concerned, the condensation is very considerable, the volume reduction between the spermatid nucleus and sperm nucleus varying between 80 per cent. and 95 per cent. in the different species (Seshachar, 1943).

Centrioles.—The disposition of the centrioles in the Amphibian sperm varies very much and in this respect, the Anura and Apoda resemble each other while the Urodela stand apart. In the Anura, the centrioles lie one behind the other posterior to the nucleus (Fig. 1 *B*, C^1, C^2) in the form of granules (except in *Bombinator* where they lie alongside the nucleus and not behind). They are generally distinct from the nucleus and close to each other. In *Hyla* a short distance separates the two centrioles. From the distal centriole arises the flagellum. In the Apoda too, the centrioles lie behind the nucleus but in this group they are far more deeply and intimately associated with the nucleus (Fig. 1 *C*, C^1, C^2). The proximal centriole becomes a flattened disc-shaped structure adhering firmly to the nucleus behind and so intimately fused with it in the adult sperm as not to be distinguishable from it except by the use of special reagents. The centre of the disc has an orifice through which the distal centriole, becoming a spindle-shaped granule centres into the nucleus and lies embedded in it. In the adult Apodan sperm, therefore, it is not possible to distinguish the centrioles, as it is in the Anuran sperm, where the centrioles are clear and separate from the nucleus.

But the condition in the Urodela is very striking. The proximal centriole becomes

greatly enlarged as a deeply staining block adhering to the nucleus behind it, while the distal centriole becomes a ring and is drawn out along the flagellum as a long pessary-shaped structure extending over a considerable length of the tail filament. No granular centrioles are found in the adult spermatozoon of any Urodele.

The 'Middle piece'.—The term 'middle piece' is used to designate any region, however different in structure, provided it is immediately posterior to the nucleus. This is more clear in Amphibia than in any other group, for the 'middle piece' is different in the three orders of Amphibia. In the Anura, the centrioles are, as has been observed, behind the nucleus and the mitochondria invest the base of the axial filament as a sheath. The mitochondrial sheath with the two centrioles is called the 'middle piece'. In *Hyla* (Retzius, 1906), the centrioles are separated by a short space and this space with the mitochondrial aggregation is called the 'middle piece'. In the Apoda, since both the centrioles are more closely associated with the nucleus than in the Anura, the 'middle piece' is purely a mitochondrial aggregation behind the nucleus. In the Urodela on the other hand, the conditions are quite different. There are generally no mitochondria in the adult urodele sperm and the term 'middle piece' is, therefore, applied to the conspicuously large proximal centriole which is just behind the nucleus (Fig. 1 *A*). So, while the term 'middle piece' is applied to the mitochondrial aggregation in the Anuran and Apodan sperms, it is the proximal centriole itself that is termed 'middle piece' in the urodele sperm.

The mitochondria in the 'middle piece' of the Apodan sperm (presumably also in the Anuran) occur inside a cylindrical transparent tube fitted to the posterior end of the nucleus. The origin of this tubular sheath I have been able to trace in *Ichthyophis* (1943 *a*). Around the posterior end, and at the sides of the transforming spermatid nucleus there appears a space which is gradually pushed backwards and becomes the tubular sheath in which mitochondria aggregate and arrange themselves in a spiral fashion around the axial filament. The presence of three different structures in the 'middle piece' of the Apodan sperm has to be recognised: (1) The axial filament which arises in relation with one of the centrioles, (2) the mitochondrial aggregation which is a spiral investment around the base of the axial filament, and (3) the transparent tubular sheath which holds the mitochondria in place. While the earlier workers had described the first two of these, the presence of the third has not been explained so far.

From the foregoing account of the spermatozoa of the three groups of Amphibia, it is clear that they fall under three entirely different categories. Of these, the Anuran sperm is the simplest. The Apodan sperm resembles it greatly, especially in the close association of the two centrioles with the nucleus as well as in the mitochondrial 'middle piece'. The Urodelan sperm on the other hand, in the great enlargement of the proximal centriole to form a solid body and the curious elongation of the distal centriole to form an accessory structure running along the tail filament, provides a condition unique in the animal kingdom.

I wish to thank Prof. A. Subba Rau for his kindness and encouragement and for his many useful suggestions.

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OBITUARY

SIR EDWIN BUTLER, C.M.G., C.I.E., F.R.S.

AS it must to all living beings, death came to Sir Edwin Butler on April 4, 1943, following an attack of influenza. That he was ill was known for some time but no one had realised that his end was so near.

Edwin John Butler was born on August 13, 1874, in Co. Clare, Ireland and received his early education at the Queen's College, Cork. He took the Bachelor's degree in medicine from the Royal University, Ireland, in 1898, but having come under the influence of Professor M. M. Hartog at the Queen's College, he preferred the study of fungi to the practice of medicine. That aquatic Phycomycetes should attract him in Hartog's laboratory is natural and obtaining a travelling fellowship in 1899, he spent two years on the continent where the study of fungi had made great strides. He studied under Cornu and van Tieghem at Paris and Poirault at Antibes and spent some time at Freiburg where a few decades previously de Bary studied and taught mycology and attracted students from all over Europe.

In 1901 Butler was appointed Cryptogamic Botanist to the Government of India with headquarters at the Royal Botanic Gardens, Calcutta. In India fungi had been collected by Koenig, a student of Linnaeus and the first

Indian fungus was named by Linnaeus himself, *Lycoperdon pistillare* [= *Podaxon pistillaris* (L.) Fr.]. Other collections had also been made and named but a study of fungi did not begin in India until after D. D. Cunningham's arrival in 1869.

Cunningham, an Indian Army Medical Officer, came to India to discover the cause of Cholera and other tropical diseases and later became Professor of Physiology at the Calcutta Medical College. He had received training in mycology under Berkeley, Hallier and de Bary and his interest in fungi was thus natural. It was his practice, therefore, to deal with all enquiries regarding fungi received at the Royal Botanic Gardens at Calcutta from all parts of

India. At about the same time, between 1885-1892 to be precise, A. Barclay was conducting at Simla very critical experiments on the life-histories of rusts. The work done by Cunningham and Barclay must have been so effective that Government evidently realised the need for the services of a whole-time Cryptogamic Botanist which led to Butler's appointment. In 1902 Butler was transferred to Dehra Dun and in 1905 to the newly started Agricultural Research Institute at Pusa with the designation of Imperial Mycologist.

In India the years 1901 to 1921 must have been of great activity. Fungi, both those occurring on wild and crop plants had to be collected, studied and identified; a mycological laboratory had to be established, a herbarium started and contacts made with mycologists abroad for obtaining literature and specimens. Pressing problems in plant diseases needed immediate attention and countless enquiries had also to be attended to but above all students had to be trained to man the different provincial agricultural departments.

To these tasks Butler set himself with zest and vigour. The work started in Europe on aquatic Phycomycetes was completed, four species of *Pythium*, five of *Pleolpidium* and two of *Nowakoskiella* being established. The classical studies on the diseases of palms and sugarcane, on wilt of pigeon peas, on wheat rusts, on the downy mildews, etc., were commenced and carried out with thoroughness and the papers written on them will ever remain models of clear thinking, lucidity and scholarship. Collections made in different parts of India were all carefully studied and named, resulting in five papers on Indian fungi in collaboration with Sydow. One genus of rusts, *Cystopsora* and another of water moulds, *Allomyces*, were established, the latter of which has yielded the most interesting life-history among the Oomycetes. Nearly one hundred and fifty species stand to Butler's credit, some of them with Sydow.

In 1910 Butler started collecting material for a book on Indian plant diseases, *Fungi and Disease in Plants*, published in 1918, being the result. This book which is now unobtainable, will, in spite of any number of new books, ever remain the reference text in India. In 1931 he published, with G. R. Bisby, the *Fungi of India*.

Butler finally left India in 1921 to take up the Directorship of the newly established Imperial Bureau of Mycology, now Imperial Mycological Institute, at Kew. Here he became a figure not only of Empire but of international repute. He founded the *Review of Applied Mycology*, a journal indispensable in all institutions where mycological problems, be they agricultural, medical or industrial, have to be dealt with. In 1926 he was elected to the fellowship of the Royal Society and to its Council in 1934. He was the Chairman of the mycological section of the International Congress of Plant Science held at Ithaca in 1926 and gave, in 1939, the Lowell lectures at Harvard, from where had lectured such eminent men as Farlow, Thaxter and Blakeslee.

Indian mycologists will always speak of him in terms of gratitude for the fillip he gave to the study of fungi, for founding a fine herbarium and for the exhaustive research he did on the plant diseases of India. His knowledge of Mycology and Pathology was encyclopædic and in him the two sciences represented a happy mean.

He was made a C.I.E. in 1912 and C.M.G. in 1931 and was Knighted in 1939. He leaves behind Lady Butler, one son and two daughters.

B. B. MUNDKUR.

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TWO MORE PLANETARY SYSTEMS

OBSERVATION has at last come to the aid of theory which had given conflicting verdicts on the uniqueness of the Solar System. A planetary companion to the 61 Cygni system has recently been discovered by Dr. K. Aa. Strand (Feb. 1943) from a study of parallax observations of the star. A periodic deviation from the Keplerian orbit was found for the system, and this can only be due to the presence of a third body (61 Cygni C) of small mass. 61 Cygni C is found to be sixteen times as massive as Jupiter and very feebly luminous. It can, therefore, be classified as a planet.

Reuyl and Holmberg (Jan. 1943) have about the same time discovered a non-solar planetary body of even smaller mass in the binary star system, 70 Ophiuchi. As both the stars, 61 Cygni C and 70 Ophiuchi, are within 10 parsecs of the Sun (Jeans, 1929*a*), it is significant that two other planetary systems have been discovered quite close to our Solar System.

These observations very much weaken the case for the tidal theories of Jeans (1919) and Jeffreys (1929), according to which planetary systems should be very rare. Jeans (1929) estimates that on his theory about one planetary system in the whole of the galactic system should be formed every 5,000 million years. This gives us at the most two planetary systems in our galactic system, if we take the age of the Universe to be between 10^9 and 10^{10} years. Planetary systems have hardly any chance of being formed on Lyttleton's binary star collision theory (1938).

Banerji's Cepheid theory (1942), on which a star passes an oscillating Cepheid at a moderate distance and disrupts it, makes the birth of planetary systems much more probable. We shall quote Banerji on this point (1942*a*), "One conclusion seems to be irresistible. If the theory be correct in its essentials, there may be more planetary systems than at present supposed". Banerji's conclusion is fully borne out by the recent observations.

It may be remarked that the author has recently advanced a Cepheid theory of the origin of binary stars (Sen, 1941-42), which makes it possible for binary stars to possess planetary systems. Radiation of energy and consequent increase of angular velocity causes a Cepheid to break up into a double star system. The filamentary ribbon connecting the two stars may condense into planets.

Department of Mathematics,
Allahabad University,
August 7, 1943. H. K. SEN.

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EFFECT ON B.H. CURVES OF ELECTRIC CURRENTS THROUGH A TRANSFORMER CORE

THE B.H. curves for ferromagnetic materials as obtained on a cathode-ray oscillograph provides a good visual and photographic method for studying the variations in the magnetic properties of these materials with various physical changes. The hysteresis loop can be obtained on the oscillograph provided only with electrostatic deflection plates (Fig. 1) if a resistance (R_1) is included in series with the primary coil of the transformer, and a suitable phasing condenser (c) and resistance (R_2) are present in the secondary circuit. The magnetising force is proportional to the primary current and thus to the voltage built in the series resistance (R_1) and this is applied after amplification for horizontal deflection of the beam, while the voltage in R_2 is proportional to B and is applied after amplification to the plates giving vertical deflection.

With this circuit we have tried to study any change in the loop if simultaneously with the current through the primary or secondary coils, we send an electric current through the iron core of the transformer (shown by arrows).

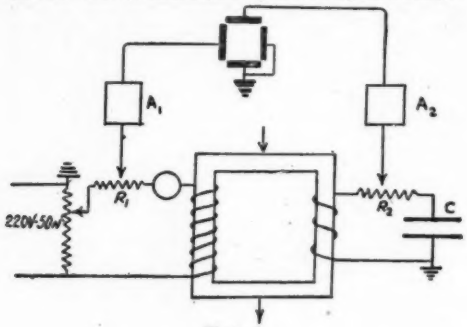


FIG. 1

A_1, A_2 Amplifiers

Some change would not be unexpected on general theoretical considerations as in each cycle of current passing through the primary, there is a reversal of the magnetic field through the core and the spin axis of the magnesting electrons would reverse in direction each time. Now if, in addition to this magnetic field acting on the core, an electric current was to traverse it, the flow of these myriads of electrons may interfere with the free reversal of the spin axes and produce a widening of the hysteresis loop.

A photographic exposure of the hysteresis pattern was obtained on the camera plate, first

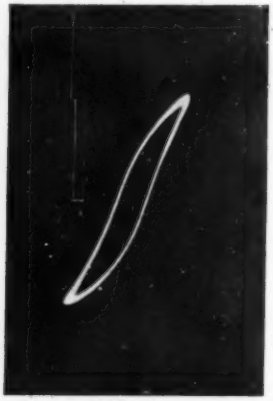


FIG. 2

in the normal condition, *i.e.*, without current in the core and then without disturbing the position of the camera or any other part of the apparatus, the current through the core was switched on, and a further exposure given on the same plate.

With D.C. current upto 5 amps., the two patterns are completely superposed showing no trace of change. Same result is obtained, with the direction of the current reversed (Fig. 2). With an A.C. current (3 amps.), and same frequency (50 cyc.) as that flowing through the coils, a broadening of the loop takes place (Fig. 3), with the peculiarity that the widening is marked only during the two quarter

FIG. 3

cycles when the magnetising current is increasing on the positive side or on the negative side. During the quarter cycles when the magnetising current is decreasing the two traces are superposed. With the A.C. currents induced effects in the coils have to be taken into consideration. But the change depicted is quite peculiar and although induced effects will be there, the atomic magnetic properties may also have to be considered.

However, we are carrying on these experiments along with other variations as to temperature, etc., which will throw more light on this phenomenon. We owe our gratitude to Prof. J. B. Seth for facilities provided for this work.

Physics Laboratories,
Government College,
Lahore,
July 27, 1943.

H. R. SARNA.
P. N. KALIA.
JAI DYAL DHINGRA.

1 K. Kreiselheimer, *J. Sci. Inst.*, 1942, **19**, 137. 2. Reyner, *Cathode Ray Oscillograph*.

SPECIFIC HEAT OF SOLID CARBON DIOXIDE

IN a symposium of papers[1] which appeared in the *Proceedings of the Indian Academy of Sciences*, the Raman theory[2] of specific heat has been applied to many elements and simple ionic compounds, namely, rocksalt and sylvine. The thermal energy of rocksalt calculated on the basis of the discrete, though weak, Raman lines reported by Fermi and Rasetti[3] for a single crystal has been shown by the author[4] to be in good agreement with the experimental data. In the present note, the investigation has been extended to molecular compounds.

Sirkar and Gupta[5] have observed an intense and sharp Raman line at 58 cm.$^{-1}$ for solid carbon dioxide, besides the inner frequencies of the molecule. The latter, however, attributed

this line to inter-molecular oscillations of polymerised groups of molecules in the solid. In a note[6] to *Current Science*, I have shown that this frequency-shift agrees approximately with the Lindemann frequency as well as with the Pauling rotational frequency of solid CO_2. I was thus led to conclude that the new line observed by Sirkar arises from coherent rotational oscillations of molecules in the crystal lattice. This point of view has been fully supported by later theoretical and experimental researches on the subject by several authors.

In the present note, the following frequencies, duly corrected for low temperatures, are adopted for the calculation of specific heat of carbon dioxide: 668, 1,336 and 2,350 cm.$^{-1}$ for internal frequencies and 63 cm.$^{-1}$ for rotational frequency and 122, 61·5 and 32 cm.$^{-1}$ for the first, second and third order lattice translational frequencies. The specific heat, C_v at any temperature T° K. is represented by the relation,

$$C_v = 1/3E\left(\frac{958}{T}\right) + 1/3E\left(\frac{1915}{T}\right) + 2/3E\left(\frac{2370}{T}\right) + 8/3\cdot 1/3E\left(\frac{93}{T}\right) + 3/4\cdot E\left(\frac{180}{T}\right) + \frac{7}{4\times 8}E\left(\frac{90}{T}\right) + \frac{7}{4\cdot 8\cdot 8}E\left(\frac{45}{T}\right).$$

TABLE I

T°K	C_v Raman Theory	C_p Observ.	C_v Observ.	C_p B & Z
15	0·52	·54	·54	·52
20	1·286	1·23	1·23	1·16
30	3·067	3·08	3·08	2·95
40	4·624	4·69	4·65	4·70
50	5·824	6·10	5·88	6·11
60	6·715	7·18	6·82	7·17
70	7·437	7·97	7·48	7·98
80	7·866	8·58	7·77	8·61
90	8·237	9·11	8·29	9·12
100	8·541	9·53	8·53	9·54

The experimental value of C_v is computed from the data for C_p and the melting point of CO_2. The values of temperature, C_v (calculated), C_p (observed) and C_v (observed) are given in columns 1 to 4 of Table I. Column 5 gives the values of C_p calculated by Brucksch and Ziegler[7] on the basis of the theoretical views of Andrews and Lord for comparison. The excellent agreement between the experimental values of specific heat and those calculated according to Raman's theory shows that the latter is applicable to molecular compounds as well.

University College, Trivandrum, *September* 6, 1943. C. S. VENKATESWARAN.

1. Symposium of papers on thermal energy of crystalline solids, *Proc. Ind. Acad. Sci.*, (A), 1941, **14**, 459-506. 2. Raman, C. V., *Ibid.*, 1941, **14**, 459. 3. Fermi and Rasetti, *Zeit. f. Physik*, 1931, **71**, 689. 4. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, A, 1941 **14**, 506. 5. Sirkar and Gupta, *Curr. Sci.*, 1937, **6**, 21. 6. Venkateswarn, C. S., *Ibid.*, 1938, **6**, 378. 7. Brucksch and Ziegler, see *Joun. Chem. Physic*, 1942.

ABSORPTION SPECTRA OF ORTHO-DICHLOROBENZENE

A CAREFUL study of the ultra-violet absorption spectra of *o-dichlorobenzene* has been made using a very simple method of developing the absorption bands. A hydrogen discharge tube was used as the ultra-violet source and the vapour was contained in a tube 20 cm. long and 2·5 cm. in diameter with plane quartz windows at both ends. Twelve absorption bands have been obtained at the optimum condition corresponding to 14 mm. mercury pressure and a temperature of 24° C.

The following are the wavelengths and wave-numbers of the band heads:—

No. of bands	λ in A° (in air)	ν per cm.$^{-1}$ (in vacuum)
1	2,799·1	35,716·5
2	2,794·2	35,779·1
3	2,774·1	36,038·4
4	2,767·3	36,126·9
5	2,762·6	36,187·1
6	2,757·5	36,254·0
7	2 751·6	36,293·5
8	2,713·3	36,844·5
9	2,708·2	36,913·9
10	2,684·9	37,234·2
11	2,680·0	37,302·3
12	2,596·1	38,507·8

Muslim University, Aligarh, *January* 10, 1943. KHALILULLAH SIDDIQI.

AN ORTHOPYROXENE FROM DODKANYA, MYSORE

AN orthopyroxene occurs in large grains, sometimes 1 cm. in length, in a norite of the gneissic complex of Dodkanya bordering the Ultra-basic intrusives of the area. Mr. B. Rama Rao, Director of Geology, Mysore Geological Department, has had this mineral analysed in connection with his memoir on "Charnockites", which he is now writing. The analysis is herein reproduced with his kind permission.

The orthopyroxene is striated on the (100) and pyramidal faces, and, under crossed nicols, shows, occasionally, minute lamellæ, crossing the prismatic cleavages on pyramidal faces. The lamellæ are localised in certain areas of the same plate. The mineral plates show strain shadows. When tilted on the Universal Stage, the lamellæ on the pyramidal faces disappear towards (010) and (001) faces, but become sharp on the (100) face with alternating dark and bright bands. They give an extinction angle of ± 6° on pyramidal faces, which are cut near (010 — 100) zone, and ± 3° on the same faces, when tilted to the (100) position. The very minute lamellæ are, therefore, slightly variable in chemical composition. The mineral contains plenty of inclusions of plagioclase, which develop radial pressure cracks in the orthopyroxene host; and

a brownish-green amphibole, typical of the charnockites, develops at the contact of the guest with the host.

The crystal is set in Fig. 1, following the Pseudo-tetragonal rule applicable to crystal-setting in the Orthorhombic system, whereby angle $a\,m < b\,m$.

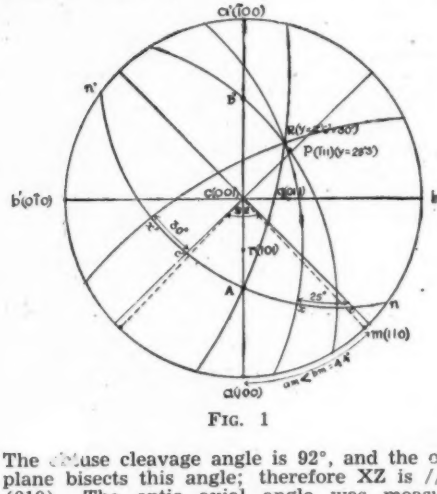


FIG. 1

The obtuse cleavage angle is 92°, and the optic plane bisects this angle; therefore XZ is // to (010). The optic axial angle was measured directly on the Federov's stage, on a (100) section of a grain not showing the lamellæ, by the method of sharp extinction in the 45° position. The optic axial angle is 73° 58′. The mineral is negative in optic sign and positive in elongation. $X = a$, $Y = b$ and $Z = c$; $B x_{ac} = X$ and is $\perp r$ to (100). The mineral is intensely pleochroic with X = clear red, Y = pale yellow, and Z = clear green. The refractive indices are $\alpha = 1{\cdot}684$, $\beta = 1{\cdot}690$ and $\gamma = 1{\cdot}694$. $\gamma - \alpha = {\cdot}010$. The optical characters of this mineral are between those recorded for hypersthenes, from Lauterbach and Labrador.[1]

	Lauterbach	Orthopyroxene Dodkanya	Labrador
% FeO + MnO	10·6	10·5	14·8
2V over Z	95° (2V over X = 5°)	104°2′ (2V over X = 73°58′)	—
Ng	—	1·694	1·705
Nm	1·685	1·690	1·702
Np	—	1·684	1·692
Ng − Np	—	0·010	0·013

(100) and (010) sections give straight extinction, but others give oblique extinction with a maximum extinction angle of 31°. The section giving an extinction angle of 31° does not show any lamellæ. To test if this section was not cut parallel to a pyramid of the orthopyroxene, the grain was mounted on the universal stage, and the emergence of optic axis B′ was located giving the co-ordinates $a'_{E-W} = 20°\ 50'$ and $a'_{N-S} = 29°$ for the pole R. The pole R of the hypothetical pyramid and its trace are projected in Fig. 1. By the Biot-Fresnel Law, the cleavage angles on this hypothetical pyramid are the arcs x', c' and xc, which read 30° and 25° respectively. The extinction angle of 30°, thus deduced by the graphical method, is in close agreement with the observed angle 31°. For comparison is reproduced the calculated angle 28° 3′ for the unit pyramid P (1̄11) of the hypersthene of Halagur.[2] The high extinction angles of the orthopyroxene under study, are therefore, the extinction angles, theoretically possible on pyramids of orthorhombic crystals.[3]

The chemical composition of the mineral is herein set down, alongside the chemical composition of orthopyroxenes of the Bushveldt type, studied by H. H. Hess and A. H. Phillips.[4] Analysis of a hypersthene from the Charnockites of Uganda is also included.

	I	III	IV	Orthopyroxene Dodkanya	Hypersthene Uganda	Metasilicate molecules: Orthopyroxene Dodkanya
SiO_2 ..	53·81	53·60	54·63	52·66	55·15	
Al_2O_3 .	1·67	3·51	2·39	1·28	6·50	$MgSiO_3$ — 66·40
Fe_2O_3 ..	1·48	0·79	1·71	5·47	2·10	
FeO ..	6·70	11·38	7·07	9·36	17·68	$FeSiO_3$ — 17·29
MgO ..	33·15	25·34	30·30	26·58	16·62	
CaO .	2·32	4·19	2·20	3·30	1·58	$CaSiO_3$ — 6·84
Na_2O ..	0·04	0·25	0·45	0·84	—	
K_2O .	0·06	0·03	0·11	0·18	—	Na_2SiO_3 — 1·59
H_2O ..	0·54	0·27	0·52	0·19	—	
H_2O ..	0·08	0·04	—	0·32	—	$MnSiO_3$ — 1·70
TiO_2 ..	0·09	0·29	0·36	tr	0·03	
P_2O_5 ..	tr	—	0·12	nil	—	$AlAlO_3$ — 1·28
Cr_2O_3 ..	0·38	—	—	—	—	
MnO ..	0·16	0·19	0·14	0·89	0·34	$FeFeO_3$ — 5·47
	100·16	99·88	100·00	100·73	100·00	100·57

I, III, IV copied from the *American Mineralogist*, 1938, **23**, 453, H. H. Hess and A. H. Phillips.

Orthopyroxene, Dodkanya.—Analyst, B. Sadasiva Raju, Chemist, Mysore Geological Department.

Hypersthene, Uganda.—A. W. Groves, *Q.J.G.S.*, 1935, **71**, 156.

The chemical analysis of the Dodkanya orthopyroxene does not accord with that of the Charnockite type, but is in fair agreement with the analysis of the Bushveldt type, except for the high content of ferric iron, which accounts for the intense pleochroism of the Mysore mineral. The presence of alumina and alkalis in the analyses of orthopyroxenes is pointed out by Hess and Phillips to be characteristic of orthopyroxenes of the Bushveldt type. It may be remarked that the ratio of soda to potash, and of both to lime, are ratios, fairly constant in the rock analyses of the Charnockites of India. Hess and Phillips ascribe the CaO content to the presence of the Diopsidic molecule as lamellar intergrowths in the orthopyroxene host; they also hold that some of the low extinction angles are due to this intergrowth.

Calculating the chemical analysis in terms of metasilicate molecules, and expressing the mineral in terms of its minals, the mineral of Dodkanya has the formula,

$$En_{60}Hy_{17}Di_{7}\triangle_{16}.$$

Winchell[5] has proposed the restriction of the term Bronzite to an FeO tenor of 5-14 per cent. or of $FeSiO_3$ tenor of 9·2-25·72 per cent. The mineral under study is, therefore, a Bronzite of the Enstenite series, but it has not the typical inclusions of Bronzite.

University of Mysore,
Bangalore, P. R. J. NAIDU.
August 14, 1943.

1. Winchell, A. N., *Elements of Optical Mineralogy*, 1933, **2**, 217. 2. Naidu, P. R. J., *Curr. Sci.*, 1943, **12**, No. 5, 158. 3. Johannsen, A., *Petrography*, 1937, **3**, 213. 4 *American Mineralogist*, 1938, **23**, 453. 5. Alling, H. L., *Interpretative Petrology of the Igneous Rocks*, 1936, p. 85.

A NOTE ON THE COAGULATION STUDIES OF THE LATEX OF *CRYPTOSTEGIA GRANDIFLORA* R. Br. AS A WAR-TIME SOURCE OF VEGETABLE RUBBER

IN a previous communication[1] describing the Chemical and Technological investigations on *Cryptostegia grandiflora*, a method of coagulating cryptostegia latex with water was reported. This method consists in mixing 20 volumes of distilled water, 15-16 volumes of tap water or 6-8 volumes of hot water, to latex whereby it gets coagulated yielding a white coagulum of rubber which can be sheeted and a clear straw coloured or red serum.

When the pH value shifts towards the alkalinity side, coagulation takes place. Continuation of the investigations showed that although this method has the advantage that it does not require acids or other chemicals, it has the disadvantage that on the large scale it involves the use of large quantities of water and bigger coagulating tanks. It was, therefore, considered necessary to devise a still simpler and more advantageous method of coagulation. Investigations were carried out with a large number of substances such as calcium and sodium chlorides, sodium, potassium, calcium and ammonium hydroxides and carbonates, alcohol, acetic acid and formaldehyde and eventually the following method has been found to answer the purpose in view. The following tentative conclusions can be drawn:—

1. Latex can be coagulated by diluting it with water (1/100 part that of latex) of an alkalinity which would bring the final pH value to the vicinity of 7·7.

2. The per cent. dry rubber obtained does not vary much with coagulants.

3. Three volumes of a solution of lime water saturated at 31° C. (approximately N/25·5) are required to bring about coagulation, while of N/10 NaOH, N-NaOH, 10 N-NaOH, only 1, 1/10 and 1/100 volumes respectively are required.

4. The quality of rubber in every case is satisfactory and the coagulum can be sheeted.

Description of the Method.—Take latex (20 c.c.) in a beaker, add 10 N-NaOH (0·2 c.c.). The solution turns dirty pink. On warming to 80-90° C. it separates into a clear blood red to brownish red serum and a white coagulum of rubber. The coagulum is sheeted and after washing it with water till it is free of alkalinity, it is dried at 90-95° C. in an air oven.

The details will appear elsewhere.

Imperial Agricultural Research Institute, New Delhi, *August* 17, 1943. B. VISWA NATH. R. H. SIDDIQUI. S. A. WARISI. V. V. K. SASTRY.

1 *Journal, Board of Scientific and Industrial Research*, July 1943, **1**, No. 4, 365–57.

THE BERBERINE CONTENT OF *COSCINIUM FENESTRATUM* (COLEBR.)

WE are glad to confirm the observation of Varier and Pillai[1] that berberine is the predominant alkaloidal constituent of *Coscinium fenestratum* by putting on record a brief note of an examination of Ceylon material carried out in 1939.

Air-dried stems (moisture 6·8 per cent., ash 2·6 per cent.) were exhausted with 95 per cent. alcohol in a Soxhlet apparatus, which removed 9·2 per cent. of material. From the alcoholic extract berberine is readily precipitated as the acid sulphate by addition of a slight excess of sulphuric acid (the yield of crude salt 4·1 per cent.).

The combined filtrates after separating and washing the berberine acid sulphate with alcohol, were evaporated and taken up in water and ether; the latter solvent removed resinous matter (4·1 per cent.). The aqueous solution after thorough ether extraction was made alkaline with caustic soda and again extracted with ether which removed 0·67 per cent. of crude alkaloids. After treatment with carbon dioxide, the aqueous liquor yielded to ether a further 0·2 per cent. of crude phenolic alkaloids.

We should not, therefore, go as far as Varier and Pillai in stating that berberine is the only

alkaloid present and we consider that further investigation (for which we have not the opportunity) would be worth while.

Composition of Ash.—Insoluble in 2-N hydrochloric acid: 6·6, CaO 36·8, K_2O 7·6, Cl' 0·38 per cent. The high calcium content is noticeable, corresponding to 1·0 per cent. CaO on the original stems.

Coconut Research Scheme,
Lunuwila, Ceylon, R. CHILD.
September 1, 1943. W. R. N. NATHANAEL.

1. Varier N. S., and Pillai, P. P., *Curr. Sci.*, August 1943, **12**, No. 8, pp. 228–229.

THYROXINE-IODINE CONTENT OF THYROID GLAND POWDERS OF INDIAN MANUFACTURE

IN June 1942, Prof. B. B. Dey of the Madras Presidency College stated in a personal communication to the writer that "the thyroid glands of cattle collected in Madras have been found to contain a much higher iodine content than the continental specimens". This statement, not being in consonance with the widespread belief that Indian cattle are poor sources of glandular products, did not attract much attention of the writer and his co-workers at that time. Evidences have since been obtained which strongly support the statement of Prof. Dey and as this is likely to have a definite bearing on the manufacture of glandular products in India, the publication of a 'note' is considered worth while.

Desiccated Thyroid gland powders prepared from local glands in a University Chemical Laboratory, in a Research Institute and in a commercial firm were carefully tested for their thyroxine-iodine contents by the method outlined in the B.P., 1932, and the First Addendum to the B.P., 1936, with the following results:—

Sample from:	*Thyroxine-iodine*
(1) Univ. Lab. (S. India) (Average—3 determinations)	0·33 per cent.
(2) Research Institute (S. India) (Average—3 determinations)	0·20 per cent.
(3) Commercial Firm (Bengal) (Average—3 determinations)	0·18 per cent.
B.P. limits—(0·09 to 0·11 per cent.)	

Three samples of Thyroid powder obtained from Great Britain and Canada in 1939 and stored in the Refrigerator in sealed amber bottles were simultaneously tested for their thyroxine-iodine contents with the results given below:—

Sample from:	*Thyroxine-iodine*
(1) A. H. & Co., Ltd. (Average—3 determinations)	0·142 per cent.
(2) B. D. H. & Co. (Average—3 determinations)	0·235 per cent.
(3) Canadian Sample (Average—2 determinations)	0·120 per cent.

It will be seen that excepting in one instance (No. 2), thyroxine-iodine content of foreign thyroid gland powders are lower than the values obtained with powders prepared from glands of Indian cattle.

In addition to this, the author has carried out biological assays on several samples of thyroid bearing the name of Indian manufacturers but where no information was available with regard to the exact origin of the powders. Presumably some of these are of *Indian* make and in many such cases, a potency higher than B.P. (using a standard powder with known thyroxine-iodine content as control) was obtained by the 'tadpole method'.[1] Some of these samples were received in such small quantities that confirmatory chemical assay and determination of thyroxine-iodine contents were not possible.

While it is realised that the data available are not comprehensive, a tentative opinion may be expressed that, at least as far as the thyroid gland preparations are concerned, Indian manufacturers need not always feel that the raw material obtainable in India is of an inferior grade than that obtainable in Western countries where the nutrition of the cattle is definitely superior.

I am indebted to my colleagues in the Laboratory for carrying out most of the tests.

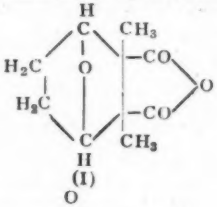
Bio-Chemical Standardisation
Laboratory, Calcutta,
August 11, 1943. B. MUKERJI.

1. Dutt and Mukerji, *Curr. Sci.*, 1942, **11**, 104.

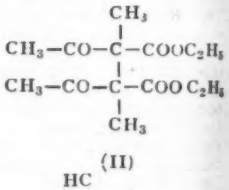
SYNTHESIS OF CANTHARIDIN

CANTHARIDIN, the active principle of *Cantharis vesicatoria* and *Mylabris pustulata* Fb. India, has been assigned the structure (I) mainly on the basis of analytical evidence by Gadamer and collaborators.[1] Recently the synthesis of desoxycantharidin (IV) by Woodward and Loftfield[2] has confirmed the structure (I) for cantharidin.

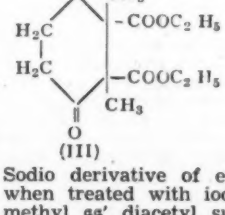
Various unsuccessful attempts at the synthesis of cantharidin have been recorded.[3] We have now synthesised cantharidin and desoxycantharidin by the following series of reactions.



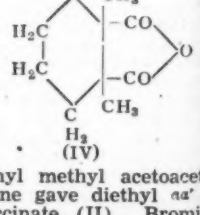
(I)



(II)



(III)



(IV)

Sodio derivative of ethyl methyl acetoacetate when treated with iodine gave diethyl αα' dimethyl αα' diacetyl succinate (II). Bromination of (II) followed by debromination by

molecular silver gave diethyl 1-4-diketo-2-3-dimethyl cyclohexane-2-3-dicarboxylate (III). Clemmensen reduction of (III) followed by hydrolysis gave desoxycantharidin (IV). Reduction of (III) by aluminum isopropoxide followed by etherification and hydrolysis by sulphuric acid gave cantharidin (I), m.p. 217°. Mixed m.p. of the synthetical cantharidin with an authentic sample from *Mylabris pustulata*, kindly supplied by Dr. P. C. Guha (Indian Institute of Science, Bangalore) to whom our thanks are due, was also 217°. Further details will be published shortly.

Maharaja Pratapsinha Chemical Laboratories, Sir Parashurambhao College, Poona, *August* 10, 1943.

(Miss) K. Paranjape.
N. L. Phalnikar.
B. V. Bhide.
K. S. Nargund.

1. Gadamer, *Arch. Pharm.*, 1914, **252**, 623, 636, 660. 2. Woodward and Loftfield, *J.A.C.S.*, 1941, **63**, 3967. 3. Coffey, *Rec. Trav. Chim.*, 1923, **42**, 1026; Steele, *J.A.C.S.*, 1931, **53**, 283; Iyer and Guha, *Jour. Ind. Inst. Sci.*, 1931, **14A**, 31; 1938, **21A**, 115; 1940, **23A**, 159; Pai and Guha, *Jour. Ind. Chem. Soc.*, 1934, **11**, 231.

CLAVICEPS PURPUREA (Fr.) Tul. AND A NEW SPECIES FROM SIMLA

Pushkar Nath and Padwick[1] recorded the presence of ergots on grasses at Simla, the hosts including *Brachypodium sylvaticum* Beauv. and *Oplismenus compositus* Beauv.

The fungus producing ergots on *Brachypodium sylvaticum* is *Claviceps purpurea* (Fr.) Tul.

A large number of *Brachypodium* ergots was found germinating in nature immediately below the plants at Simla on August 9th, 1942. These ergots measured 1·6 × 16 (1·4 – 2·0 × 7 – 35) mm. The stromata were purple or brownish yellow, slightly pitted or tuberculate, borne on a purple or brownish-yellow stipe, measuring up to 1·5 × 28 mm. The globose to subglobose capitula measured 2·8 (1·5-3·0)mm., and the ovate perithecia 147 × 259 (119-170 × 246-280) μ, asci 2·6 × 125 (2·4-3·6 × 81-173) μ and ascospores 98 (81-136) μ.

In 1942 successful attempts were made to inoculate rye and wheat with spores formed in potato dextrose agar cultures of the *Brachypodium* fungus. Ergots formed on rye, and eventually reached a maximum size of 2·5 × 13 mm., and were straight, furrowed, purplish-brown in colour, and hard at maturity. They were in every way typical of *Claviceps purpurea*. Those on wheat were smaller, measuring up to 4 × 10 mm.

In addition to the collection of germinating ergots of *Brachypodium sylvaticum*, a large number of germinating ergots from *Oplismenus compositus* was collected immediately beneath plants of that species on August 22nd, 1942. The ergots measured 1·3×6·4 (1·0-1·5×4-10) millimetres. The capitula were yellowish-green in colour, tuberculate, borne on a yellow stipe which measured up to 4·2 cm. in length. The diameters of the capitula varied from 1·0 to 1·6 mm. The perithecia measured 203 × 323 (170-229 × 280-357) μ; asci 2·6 × 178 (2·0-3·1 × 148-242) μ; and ascospores 145 (119-188) μ. Conidia found on ergots on the host plant were greenish coloured in mass, giving the sclerotia a greenish hue. Even singly they had a slightly green colour. They measured 3·8-8·4 (3·4-4·6 × 4·2-18·9) μ.

Pure cultures of the *Oplismenus* fungus were repeatedly obtained by surface sterilizing the sclerotia and plating on potato dextrose agar. Slow-growing cultures resulted, consisting of a much convoluted greenish-yellow mass, finally becoming darker green, and consisting largely of masses of spores which were somewhat smaller than those formed on the ergots, namely, 2·4 × 9·8 (1·6-3·8 × 3·3-12·6) μ.

On the basis of spore length, colour of stipe, and particularly the striking green colour exhibited by the fungus in all its stages, it differs from all known species of *Claviceps*, and is regarded as a distinct new species, to which is given the name *Claviceps viridis*.

Claviceps viridis, Padwick et Azmatullah, sp. nov.

Sclerotiis viridibus vel viride-nigris, cylindraceis, curvatis, 1·3 × 6·4 (1·0-1·5 × 4-10) mm. Stromatibus in quoque sclerotio quotcumque 4; stipitibus cylindraceis, flavis, ad 4·2 cm. longis, 0·5 vel 0·8 mm. diam.; capitulis globosis vel subglobosis, flavido-viridibus vel fuscis, tuberculosis, 1·0 vel 1·6 mm. diam. Peritheciis ovatis, ostiolatis papillaribus, 203 × 323 (170-229 × 280-351) μ; ascis cylindraceis, apicibus rotundatis, basibus attenuis, 2·6 × 178 (2·0-3·1 × 148-242) μ; ascosporidiis 145 (119-188) μ longis. Conidiis hyalinis vel palido viridibus globosis vel cylindraceis, strictis vel cuvatis, 3·8 × 8·4 (3·4-4·6 × 4·2-18·9) μ.

In terra, sub plantis *Oplismenorum compositorum* Beauv., leg. Md. Azmatullah, Simla, 25-8-42 (Typus). Statis conidicis et sclerotiis in ovariis *Oplismenorum compositorum*, leg. Pushkar Nath, Simla, Nov. 1942.

Imperial Agricultural Research Institute, New Delhi, *August* 9, 1943.

G. Watts-Padwick.
Md. Azmatullah.

[1] *Curr. Sci.*, 1941, **10**, 488.

ON THE NEMATODE *INDIANA GRYLLOTALPAE*, GEN. et SP. NOV. FROM *GRYLLOTALPA* SP.

Host: *Gryllotalpa* sp.
Location: Gut.
Locality: Calcutta.

Basir* has recently founded four new genera of nematode worms obtained from *Gryllotalpa* sp. in the Aligarh district. At the time of examination of the gut contents of the insect in this laboratory four Oxyurid worms were collected and placed at my disposal. All the specimens except one have unfortunately been mutilated at the time of collection.

The worms collected are all female and small in size. The entire specimen measures 1·7 mm. in length. The lips are inconspicuous, behind which there is a number of broad

cuticular longitudinal appendages directed backwards. The œsophagus ends in a rounded bulb with valvular apparatus. The caudal extremity

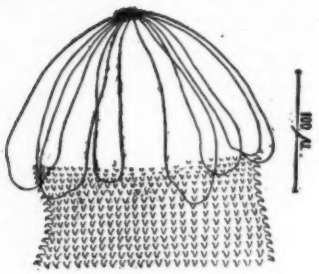


FIG. 1

Indiana gryllotalpæ. Female. Anterior extremity

terminates abruptly in a narrow spike. The cuticle, except on the caudal spike, is beset with distinct spines arranged in close-set transverse rows. The cuticle on the anterior end also appears to be devoid of spines. The spines are directed backwards and those on the posterior part of the body are larger than others. The eggs are oval and thick-shelled.

The worms under report, however, cannot be identified with any genus founded by Basir, nor with any other known nematode genus, a new genus and a species to accommodate it, appears necessary.

The detailed description of the worm will be published later.

Zoological Laboratory, G. K. CHAKRAVARTY.
University of Calcutta,
June 29, 1943.

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* Basir, M. A., *Recd. Ind. Mus.*, Calcutta, 1942, **44**, Pt. I, pp. 95–106.

EFFICIENCY OF SOME SAMPLING METHODS FOR WHEAT CROP

SAMPLING saves much time, labour and expense in getting information regarding yield, relative value of different varieties with different manures for crops spread over extensive areas. But the sampling problem is a difficult one, because the method differs from crop to crop, place to place and even from field to field. The sampling procedure depends mainly on the material to be sampled. If the material is homogeneous, the procedure is comparatively simple; but in case it is heterogeneous compiicated methods will have to be devised for taking the samples.

It is known that the error variance of the estimated value on the basis of the unit of sampling is $\left(1 - \frac{n}{N}\right)\frac{s^2}{n}$;[1] where N is the total number of units in which the whole area can be divided, n is the number of units actually sampled and s^2 is the variance between the units. Again the percentage loss of information due to sampling in any experiment is $(1-q)\frac{B}{A}\times 100$[2]; where q is the proportion sampled from each plot, B is the variance between the sampling units within the plots, and A is the variance between the plots. The above formulæ show that the efficiency of a sampling method depends on (i) the proportion sampled, (ii) the variance between the sampling units. As the variance between the units depends on their size, the size also should be such as to have a low coefficient of variation for that particular size.

Many workers[3,4] have tried to arrive at the best method of sampling by the aid of the criterion mentioned above. Their conclusions are based mostly on the results of a few experiments from plots ranging from 1/17th to 1/5th of an acre. For rice, Hubback[5] has arrived at some general conclusions from data collected over extensive areas. But no attempt has been made to judge the efficiency of different methods of sampling by any intensive work. In this note we have dealt with the efficiency of a few sampling methods with reference to wheat on the basis of the Karnal wheat uniformity trial data, which has been published in full in a previous publication.[6]

The whole area 1·1478 acres consisting of two thousand 5′ × 5′ plots (25 rows × 80 columns) was divided into four equal parts or blocks each having five hundred plots (25 rows × 20 columns). From each of these portions sampling was carried out on 1 per cent., 2 per cent., 5 per cent. and 7 per cent. basis by the following three methods: (1) Selecting 5′ × 5′ ultimate plots at random; (2) forming composite samples of 125 sq. ft. by adding the yields of five ultimate plots selected at random; (3) selecting an area of 125 sq. ft. adjoining and round about an ultimate plot taken at random. Each method of sampling was repeated twenty-five times. It will be noted that the whole area was sampled 300 times (25 samples × 3 methods × 4 percentages).

Tables I, II and III give the mean values of (i) the estimates, (ii) the variances within blocks and (iii) the percentage loss in efficiency with their standard errors based on the twenty-five samplings. Table IV shows the standard error of the differences between the estimated and the actual values on the basis of the standard deviation without taking the blocks into consideration.

TABLE I

Mean of sampling estimates in ounces for 125 sq. ft. for different sampling methods

Method of sampling	1%	2%	5%	7%
1st method	84·6 ± ·43	84·0 ± ·48	84·4 ± ·24	84·4 ± ·25
2nd method	83·2 ± ·78	84·8 ± ·42	84·8 ± ·29	86·6 ± ·61
3rd method	84·4 ± ·63	84·4 ± ·71	85·3 ± ·45	84·8 ± ·37

TABLE II

Mean variance within blocks for different sampling methods

Method of sampling	1%	2%
1st method	206·8 ± 16·0	230·6 ± 10·7
2nd method	*	29·2 ± 3·1
3rd method	*	149·8 ± 24·4

Method of sampling	5%	7%
1st method	222·2 ± 6·4	222·2 ± 6·2
2nd method	45·6 ± 2·4	99·6 ± 15·8
3rd method	131·9 ± 9·2	104·1 ± 4·1

* There was only one sample in each block.

TABLE III

Percentage loss in efficiency for different sampling methods

Method of sampling	1%	2%	5%	7%
1st method	57·8→7·1	58·7 ± 5·5	30·8 ± 3·1	24·7 ± 3·4
2nd method	*	43·3 ± 6·4	33·4 ± 3·1	43·4 ± 6·5
3rd method	*	72·4 ± 5·8	63·7 ± 5·6	47·9 ± 5·4

* There was only one sample in each block.

TABLE IV

Standard errors of the estimates for different sampling methods

Method of sampling	1%	2%	5%	7%
1st method	2·16	2·36	1·16	1·20
2nd method	3·89	2·09	1·40	2·92
3rd method	3·11	3·53	2·20	1·80

An examination of the above tables leads to the following conclusions:—

(1) The averages of the estimates are almost the same for the various methods of sampling. The standard error of these averages is for all practical purposes a minimum for the first and second methods of sampling on 5 per cent. basis.

(2) The variance within blocks is minimum for the second method of sampling on 2 per cent. and 5 per cent. bases.

(3) The percentage loss in efficiency is low for the first and second methods of sampling on 5 per cent. basis. It is also low for the first method on 7 per cent. basis.

(4) The standard errors of the estimates are comparatively low for the first and the second methods on 5 per cent. basis. It is low for the first method on 7 per cent basis also.

On the whole the present investigations indicate that 5 per cent. sampling by either the first or the second method is likely to give results with comparatively low error. The first method involves more labour for threshing than the second one and hence in actual practice the latter is preferable to the former.

Imperial Agricultural Research Institute, New Delhi, *May* 19, 1943. P. V. KRISHNA IYER. S. AZIZUDDIN AHMAD.

1. Wishart and Sanders, *Principles and Practice of Field Experimentation*, Emp. Cotton Growing Corporation, p. 44. 2. Yates and Zacopany, *J. Agri. Sci.*, **25**, 545. 3. Hudson, *Ibid.*, **29**, 76. 4. Kalamkar, *et al.*, *Curr. Sci.*, **5**, 533. 5. Hubback, *Agri. Res. Inst. Pusa Bull.*, No. 16. 6. Krishna Iyer, *Ind. J. Agri. Sci.*, **12**, 240.

SILURUS COCHINCHINENSIS C.V. FROM MYSORE STATE

COMMENTING on a collection of fishes from Kadur District, Mysore State, Bhimachar and Subba Rau[1] recently referred the species of *Silurus* found on the Western Ghats to *Silurus cochinchinensis* C.V. They pointed out that the variability found in the number of mandibular barbels in the species of *Silurus* is due to the absorption of one of the pairs with the growth of the fish and that it has no taxonomic significance. Based on this conclusion Day's *S. wynaadensis* was considered as a synonym of *S. cochinchinensis* C.V. Hora[2] considered this a valuable observation since it indicates the occurrence of one and the same species in Cochin-China, Southern China, Siam, Malay Peninsula, Burma, Assam, Eastern Himalayas and Peninsular India. This fish represents one of the important Far Eastern elements in the fish fauna of Peninsular India. Its occurrence on the Western Ghats is an important evidence in favour of the "Satpura Trend" theory of Hora.

There are two specimens of *Silurus cochinchinensis* C.V. in our collection of fishes recently made from the hill streams of Western Ghats about two and a half miles from Kottigehar. They were collected in a drainage draining towards the west and in association with *Nemachilus striatus* Day and *Bhavania annandalei* Hora. They measure 111 mm. and 70 mm. respectively in standard length. While the former has only a single anterior pair of mandibular barbels the latter has, in addition, a partially absorbed one of the posterior pair, that on the right side. The left posterior barbel is completely absorbed. This finding confirms the observation made by Bhimachar and Subba Rau.

Fisheries Section, Department of Agriculture, Bangalore, *August* 5, 1943. B. S. BHIMACHAR. AUGUSTINE DAVID.

1. Bhimachar, B. S., and Subba Rau, A., *Journ. Mysore Univ.*, 1941 (B). 2. Hora, S. L., *Rec. Ind. Mus.*, 1942, **44**, Part II, 193.

REVIEWS

The Technique of Radio Design. By E. E. Zepler. (Chapman and Hall, London), 1943. Pp. xii + 311. 21*sh*. net.

Receiver design has now developed into a highly skilled art. Most of the circuits and their peculiarities are patented. In some cases, the design peculiarities are kept so secret that only an expert service engineer can get an idea of such peculiarities after carefully handling the receivers. Consequently, the literature on the subject is scanty and is made available only in the technical pamphlets issued by the manufacturers. The book under review is an attempt to give a very elementary introduction to the subject. It abounds in numerical examples, a feature that is most welcome in books on design.

The book is divided into fifteen chapters dealing with a.c. theory, the different stages of a modern receiver and such peculiarities as selectivity, noise, screening, hum, feed-back, distortion, parasitic resonances, and power supply. There is a chapter on routine measurements and one on fault-finding. The treatment in every chapter is very clear and lucid. The subject-matter of each chapter is most logically and systematically presented. The experience of the author as a research engineer has enabled him to mention a few interesting points in every chapter and this is perhaps the one reason for the reviewer to commend the book. The printing and get-up of the book are excellent.

None of the topics treated in the book comes up for an exhaustive or complete treatment. Many of the chapters are rather defective from the point of view of a design engineer. The materials in chapters on routine measurements and fault-finding will be considered out of date for a book written in 1943. The approach to the whole problem seems to be solely based on the author's experience. This method of handling the problem may be unacceptable. The reviewer may perhaps suggest two alternative methods more universally recognised: (*a*) designing from the point of view of catering to a price market and (*b*) designing from the point of view of high fidelity reception, good selectivity and sensitivity, and easy and systematic servicing. The author has made no attempt to establish distinct criteria for either point of view and follow them up.

S. V. CHANDRASHEKHAR AIYA.

Chromatographic Adsorption Analysis. By Harold H. Strain. (Interscience Publishers, Inc., New York, N.Y.), 1942. Pp. x + 227. 37 Illustrations. Price $3.75.

It was in 1906, that Tswett devised a simple and ingenious method of adsorption analysis which was destined to play an important role in the advancement of many and varied a branch of science. To quote the picturesque language of Tswett, "Like the light radiations in the spectrum, so is a mixture of pigments systematically separated on the calcium carbonate column into its constituents, which can then be qualitatively and quantitatively determined". The method has since been extended to mixtures of constituents which are colourless.

In cases where the orthodox methods of separation, isolation and purification have failed, chromatographic methods have proved successful. The ease, elegance and simplicity of the method and the inexpensiveness of the equipment for carrying out the technique, are factors which have favoured its extensive employment in various branches of science.

The possibilities of the technique and its application have by no means been fully explored; its applications to industry are still in a stage of infancy. There are still a good number of potentially valuable adsorbents whose adsorbabilities and specificities have yet to be determined, while the fundamental aspects of the method need elucidation.

The volume under review is a valuable contribution to the subject, written by one who has added to the field by his own researches. In a series of nine chapters, the author has covered the entire field; the last chapter is devoted to a discussion of the industrial applications of the method so far known. Practical details of the technique, the choice of adsorbents, solvents and eluants, methods of locating colourless constituents in adsorbed columns, are all discussed in sufficient detail. The volume is a treatise which will not only introduce the investigator to this fruitful technique but also inspire him to achieve greater advances in the practice and application of this method of analysis.

The Indian Sugar Industry. 1942 Annual. Editor: M. P. Gandhi. (Gandhi & Co., Publishers, Fort, Bombay), 1943. Pp. lxvi + 133. Price 5-14-0.

The sugar industry in India is now firmly established as a major industry and is the second largest national industry—second only to the cotton textiles. The protection afforded has been fully utilised to expand it from a moderate size in 1932, when India was a sugar importing country depending upon Java and other places for its requirement of sugar to the extent of ten lakhs tons, to its present status when it can consider exports after meeting her internal demands. But no attempt was made to stabilise the industry and organise it on sound and scientific lines. By-product industries have not been developed. There has been a lack of foresight in not promoting the production of alcohol from molasses. War or peace, to India especially, power alcohol has great potentialities. She has yet to start her automobile industry and she could as well design and manufacture engines for burning alcohol. If the quantity of molasses is insufficient other sources of power alcohol can be developed. Plants for manufacturing rectified spirits and power alcohol need not be imported.

The entire plant can be fabricated in India. A few power alcohol plants have already been constructed in India and are expected to go into operation shortly.

The Indian sugar industry has sprung into prominence suddenly with the loss of the Far Eastern producing centres. India is now free to export sugar by sea. The outstanding feature of the year has been the assumption of control by the Government of the prices and distribution of the total sugar production in British India. The serious position created by the shortage of sulphur is bound to affect the quality of the sugar and consumers must be prepared to take in 'Brown sugar'. Mr. Gandhi has taken great pains in editing the present annual which is the VII volume. It gives a survey of the progress of the industry during the year. Various legislative enactments and Government *communiques* pertaining to the industry have been included besides numerous useful statistical tables. The present problems of the sugar industry and its future prospects have been discussed including the question of post-war reconstruction, 'the discussion of which seems to be a fashion of the day'. The suggestion to replace cane gur and sugar by the products obtained from the palmyra, thereby releasing a considerable area of good agricultural land for growing food crops, is very interesting. With a little care statements such as '... alcohol being a solvent would take the dust along with it, and it may cause starting trouble' (p. 98) could have been eliminated from the book. The Appendix 1, which is referred to in the Preface and Contents as giving a list of sugar factories in India, is missing. The *Annual* continues to be a most comprehensive and very useful reference book on various aspects of Indian sugar industry.

B. N. DAS.

SCIENCE NOTES AND NEWS

Post-War Reconstruction.—At a meeting of the Central Committee of the All-India Manufacturers' Organisation, Sir M. Visvesvaraya, the President, reviewed the progress of the organisation for the second quarter of the current year. Emphasising the importance of immediately taking up the task of proper post-war planning, he declared that no complete picture of the needs of the country could be presented until they knew in what shape or form and to what extent, political power was to be transferred to them after the war. "Unless full responsible Government is secured", Sir Visvesvaraya said, "there is no prospect of a satisfactory solution of all our major problems". After enumerating certain suggestions for immediate and post-war planning, such as a five-year plan, with a capital expenditure of at least Rs. 1,000 crores for the establishment of heavy and key industries, presided over by a Minister or Member of the Government, collection of proper production statistics, and compulsory mass education, Sir Visvesvaraya added that all his suggestions assumed that a National Government would soon be a *fait accompli*, and that the Reconstruction Committee or its Chairman had been made aware of the intentions of the Government in that respect to guide the Committee in shaping its plans.

With regard to post-war reconstruction, Sir Visvesvaraya said that no consistent policy or activity was noticeable in the attitude of the Government. A Consultative Committee of Economists was appointed in October 1941, along with four or five subsidiary Committees to deal with that question. Within the past few weeks, it was reported that a new Reconstruction Committee composed of members of the Viceroy's Executive Council, who would decide all questions of policy relating to reconstruction, had been set up. The earlier Consultative Committee of Economists seemed to have done no work, and Government had offered no explanation as to why the previous arrangement had broken down.

Concluding, he said, that there was talent in the country, which could be profitably utilised to shape reconstruction. There were more university graduates in India than in all the British Isles. In those circumstances, there could be no justification for not associating representative citizens both with the work of planning, and in the execution of reconstruction policies, so necessary to make them acceptable to the great bulk of the country's population.

Improvement of Livestock.—Addressing the staff of the Imperial Veterinary Research Institute of Izatnagar, H. E. the Viceroy emphasised the importance of Veterinary Research for livestock improvement. He said, "I think you all know how deep has been my concern for the advancement of research work in the veterinary field, ever since I first made an intensive study of India's needs, when I was Chairman of the Royal Commission on Agriculture. As Viceroy for seven and a half years, I have watched your progress with sympathy and interest, and I should like to assure you what very high importance I attach to the work which you are doing." Concluding he declared, "Scund livestock improvement must be based on three major sciences, animal genetics, animal nutrition and animal medicine, all of which are now provided for at Mukteswar and Izatnagar. If individual research workers play their part, there is every reason to anticipate in the not too distant future great advances of lasting importance, and I can think of nothing that is likely to be of greater benefit to the Indian cultivator and to India at large."

Penicillin in Canada.—Canada's Government has approved expenditure for the establishment of plants and equipment in Montreal and Taranto for the production of Penicillin, the new bacteria-killing drug.

An appreciation just made will cover the cost of creating the industry and production of the first 26,000,000,000 units of penicillin for use by Canadian armed forces. This constitutes the largest single order for medical supplies which has so far been placed by the Department of Munitions Supply.

According to Mr. C. D. Howe, Minister of Munitions, the new industry by the middle of April will be producing a weekly average of 500,000 units of penicillin. This drug, which is a British discovery, is believed to be ideal for fighting war wounds, pneumonia, blood poisoning and certain other diseases.

New Uses for Jute.—Jute in cloth form has long been used as a material for packing all kinds of articles, but recently jute in a new form has come into the market in the shape of a material suitable for packing and protecting articles during transit. According to the *Bulletin of the Indian Central Jute Committee* (Aug. 1943), a new fabric has been patented by Messrs. Simpson & Munro Ltd., 4, Lyons Range, Calcutta, and consists of laths of wood 1" × ⅛" woven into the cloth. The material presents the appearance of a sun-blind and may even be used for this purpose. It is very flexible and can be wrapped round any article down to ¾" in diameter, thus affording complete protection to the surface of articles during transit.

SEISMOLOGICAL NOTES

No earthquake shocks besides a few very minor seismic disturbances were recorded by the seismographs in the Colaba Observatory, Bombay, during the month of August 1943.

MAGNETIC NOTES

Magnetic conditions during August 1943 were more distributed than in the previous month. There were 5 *quiet* days, 20 days of *slight* disturbance and 6 days of *moderate* disturbance as against 10 quiet days, 20 days of slight disturbance and one of great disturbance during the same month last year.

The quietest day during August 1943 was the 11th and the day of the largest disturbance was the 30th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
11, 12, 22, 23, 27.	1–7, 9, 10, 14–18, 20, 21, 24–26, 29.	8, 13, 19, 28, 30, 31.

One moderate disturbance with a gradual commencement was recorded during the month of August 1943 while none occurred during the same month last year.

The mean character figure for the month of August was 1·03 as against 0·71 for August last year.

M. V. SIVARAMAKRISHNAN.

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 91, No. 4641.

"Agricultural Gazette of New South Wales," Vol. 54, Pts. 6-7.

"Biochemical Journal," Vol. 37, No. 1.

"Journal of the Indian Chemical Society," Vol. 20, No. 7.

"Calcutta Review," Vol. 88, No. 3.

"Transactions of the Faraday Society," Vol. 39, Pts. 2-3.

"Indian Forester," Vol. 69, Nos. 8-9.

"Central Board of Irrigation Bulletin," No. 40, Aug. 1943.

"Indian Central Jute Committee Bulletin," Vol. 6, No. 5.

"Indian Medical Gazette," Vol. 78, No. 8.

"Review of Applied Mycology," Vol. 22, No. 5.

"Bulletin of the American Meteorological Society," Vol. 24, No. 1.

"Journal of Nutrition," Vol. 25, No. 5.

"Nature," Vol. 151, Nos. 3840-3842.

"American Museum of Natural History," Vol. 51, No. 4.

"Canadian Journal of Research," Vol. 21, No. 4.

"Science," Vol. 97, Nos. 2522-2523.

"Science and Culture," Vol. 9, No. 3.

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Lectures on Mental Heredity. By B. Kuppuswamy. (University of Mysore), 1943. Pp. 132.

Organic Chemistry. By P. B. Sarkar and P. C. Rakshit. (H. Chatterjee & Co., Ltd., Calcutta), 1943. Pp. 576. Price Rs. 6.

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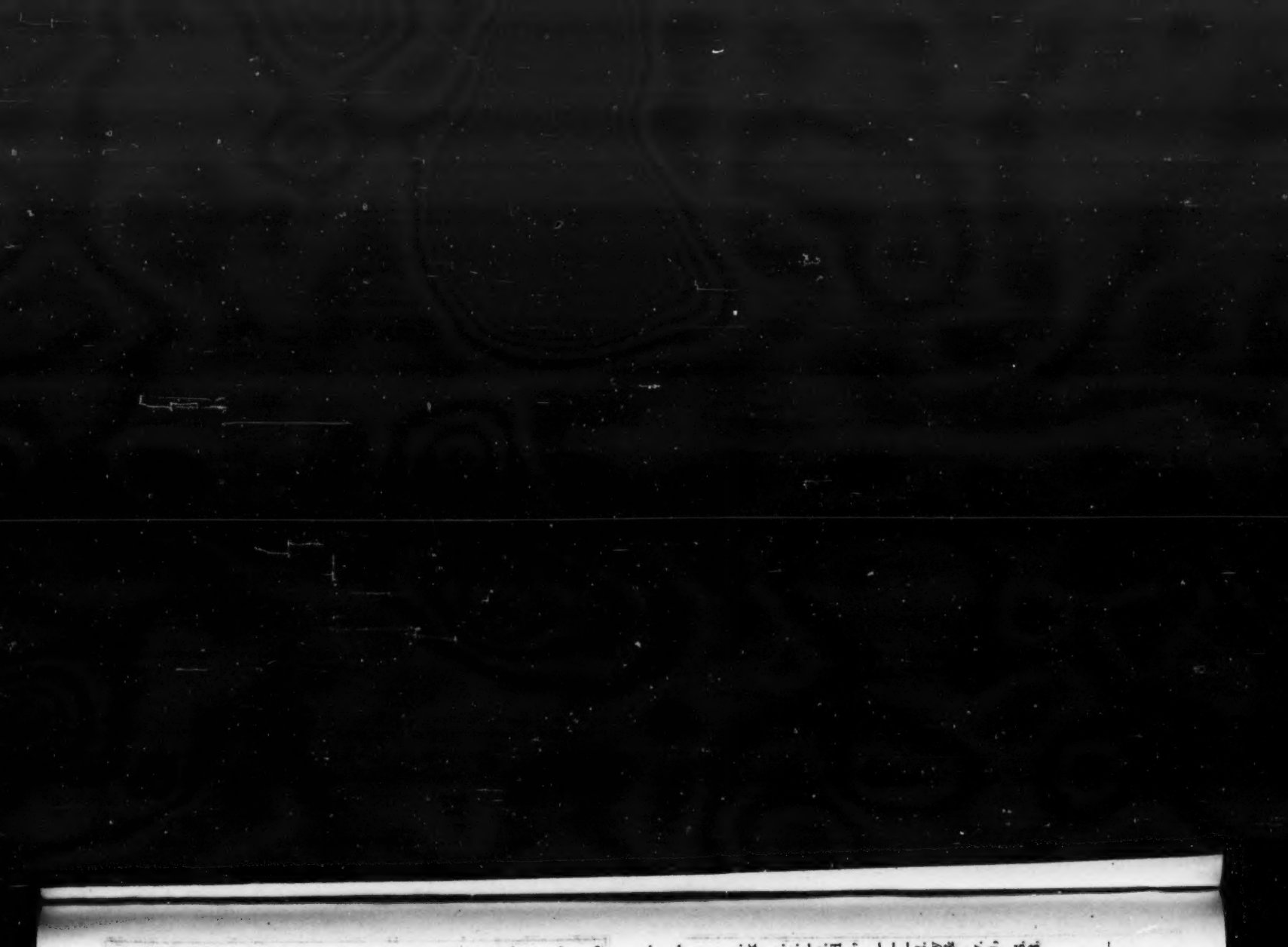
Social Studies and World Citizenship. By J. F. Brimble and F. J. May. (Macmillan & Co., London), 1943. Pp. 158. Price 6*sh.*

Starch and Its Derivatives. By J. A. Radley. Second Edition. (Chapman & Hall, London), 1943. Pp. 558. Price 36*sh.*

Time Bases, Scanning Generators. By O. S. Puckle. (Chapman & Hall, London), 1943. Pp. 204. Price 16*sh.*

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